

**Shape, Mean Radius, Gravity Field and Interior Structure of
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John D. Anderson, Robert A. Jacobson, and Timothy P. McElrath
Jet Propulsion Laboratory, Pasadena, California

Gerald Schubert and William B. Moore
University of California, Los Angeles, California

Peter C. Thomas
Cornell University, Ithaca, New York

Short title: CALLISTO GRAVITY AND INTERIOR

Abstract. Radio Doppler data generated by the Deep Space Network (DSN) from five encounters of the Galileo spacecraft with Callisto, Jupiter's outermost Galilean satellite, have been used to determine the quadrupole moments of the satellite's external gravitational field. Also, four spacecraft images of Callisto have been used to determine its three-dimensional shape and mean radius. For physically plausible compositions, and on the assumption that Callisto responds hydrostatically to rotation and Jovian tides, the gravitational quadrupole moments and the mean density place limits on possible internal density distributions. Callisto is a partially differentiated body with ice and rock-metal mixed to depths of at least about 1000 km and even, perhaps, to the center of the satellite. However, gravity and shape data alone cannot uniquely determine how the fraction of rock-metal increases with depth inside Callisto. Possible models of Callisto include a large ice-rock-metal core of essentially uniform composition surrounded by a relatively clean ice shell less than about 350 km thick, and a similar structure that has, in addition, an inner rock-metal core.

Table 1. Fits of Triaxial Ellipsoid Models to Imaging Limb Data

Image Number ^a	N ^b	Equilibrium ^c	Best Fit ^d	km/pixel	Latitude ^e	Longitude ^e
383944100	293	0.096	0.096	9.48	1.91	28.64
389556200	605	0.169	0.170	6.47	-0.17	65.86
420426068	387	0.089	0.090	13.96	-0.47	56.27
420426101	479	0.117	0.117	13.96	-0.47	56.26

^aGalileo image number from Planetary Data System (PDS) catalog.

^bNumber of data points on the limb for each image.

^cRMS residual (pixels) with equilibrium fitting model, a=2410.4 km, b=2410.3 km, c=2410.3 km.

^dRMS residual (pixels) with ellipsoidal fitting model, a=2410.4 km, b=2410.2 km, c=2410.3 km.

^eLatitude and west longitude (Deg) of the sub-spacecraft point in Callisto-fixed IAU coordinate system [Davies *et al.*, 1996].

Table 2. Gravity Parameters Inferred from Four Flybys Analyzed Separately^a

	C3	C9	C10	C21
J_2 (10^{-6})	47.4 ± 11.4	49.0 ± 12.9	33.7 ± 4.7	35.1 ± 2.6
C_{22} (10^{-6})	14.2 ± 3.2	14.7 ± 3.7	10.3 ± 0.3	10.5 ± 0.8
μ^b	0.9128	0.9327	0.1372	1.0000
C/MR^2	0.407 ± 0.039	0.412 ± 0.044	0.358 ± 0.004	0.360 ± 0.011

^aAll values referenced to radius $R = 2410.3$ km.

^bCorrelation coefficient between J_2 and C_{22} .



